

## Sexual Maturity as Determined from Ovum Diameters in Striped Bass from North Carolina

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### ABSTRACT

Sexual maturity of striped bass, *Morone saxatilis* (Walbaum), was investigated in the Albemarle Sound-Roanoke River system of North Carolina during the periods October 1956 through January 1957, October 1957 through April 1958, and April through September 1960. A method which permitted the determination of maturity through the measurement of ova was used. Percentages of mature female fish during several months prior to spawning are given by age group. At age-group VII and older, there was evidence of intermittent spawning and the possibility of cessation.

### INTRODUCTION

Important sport and commercial fisheries for striped bass, *Morone saxatilis* (Walbaum), exist in the Albemarle Sound-Roanoke River system of North Carolina. Studies of population dynamics are being conducted by the U. S. Bureau of Commercial Fisheries to evaluate the effects of fishing upon the exploitable fish in the population. As part of the research program a study was made to determine the number of years striped bass are exploited by the commercial fishery in Albemarle Sound before first spawning in the Roanoke River (April, May, and June), and to develop criteria for sexual maturity.

Scofield (1931) presented selected data which showed the probable development rate of striped bass ova. Jackson and Tiller (1952), in a preliminary study of female striped bass, predicted that ova containing yolk material and averaging 0.180 to 0.190 millimeter in diameter would take approximately 1 year to develop.

Samples from ovaries were examined in the present study to determine how effectively the size and appearance of striped bass ova in the Albemarle Sound-Roanoke River system could be used as criteria of sexual maturity, and to estimate the proportion of sexually mature female striped bass in each age group.

### MATERIALS AND METHODS

Samples of ova were obtained from commercial catches of striped bass during the period October 1956 through January 1957, October 1957 through April 1958, and April through September 1960.

The size of fish available for sampling varied because of a change in gill-net size fished. Most fish caught during the fall and winter by the commercial fishery are taken with gill nets having mesh sizes from 3¾ to 4¼ inches (stretched measure). In the spring, with the beginning of fishing for American shad (*Alosa sapidissima*), the commercial fishery also uses gill nets with mesh sizes up to 5½ inches (Sykes and Davis<sup>1</sup>). As a result, larger striped bass are caught in the spring than in the fall.

Fragments of gonads were extracted from the coelom with ear forceps inserted into the vent and through the intestinal wall. Sex was determined by microscopic examination of preserved gonadal fragments according to the method described by Sykes (1958). Both male and female gonads were examined, but only females could be used in the determination of sexual maturity.

At least 100 ova were selected randomly from each ovarian sample, and were measured on a grid-etched slide with a 45× dissecting microscope containing an ocular micrometer. Many of the ova were asymmetrical, so measurements were made parallel to the long axis of the etched slide. This method was similar to that employed by Scofield (1931) and Otsu and Uchida (1959). Merriman (1941) and Jackson and Tiller (1952) measured striped bass ova under a compound microscope with an ocular mi-

<sup>1</sup> Sykes, James E. and William S. Davis. (1960) Commercial harvest and catch composition of striped bass in Albemarle Sound, North Carolina. U. S. Bureau of Commercial Fisheries, Beaufort, North Carolina. Typewritten report, 44 pp.

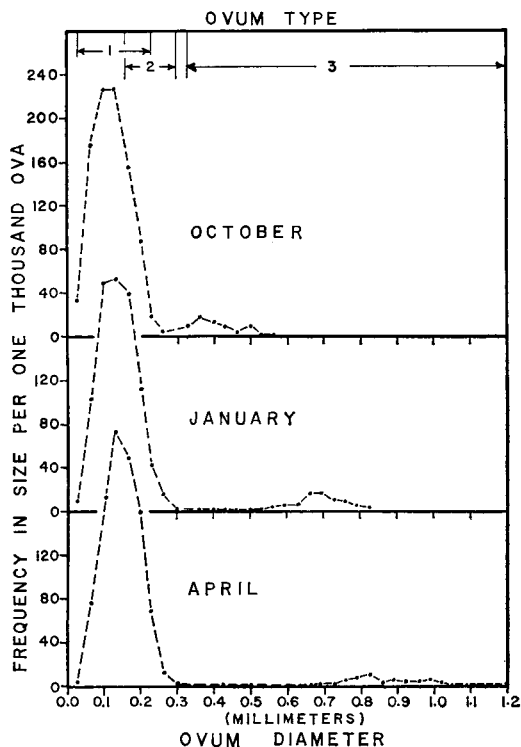


FIGURE 1.—Frequency distribution of ovum diameters from composite samples of striped bass during October, January, and April.

chrometer, but did not elaborate on the methods employed.

Scales were obtained from each fish for age determination. Fish were aged according to the number of annuli present and the number of completed growing seasons at the time of capture (Mansueti, 1961). For example, those fish that had three scale annuli but had completed four growing seasons were in age-group IV.

#### RESULTS

##### *Size and appearance of ova*

The following types of ova were identified: (1) translucent ova that ranged in size from 0.03 to 0.23 millimeter, with a mode at approximately 0.10 millimeter; (2) translucent ova that ranged between 0.16 and 0.30 millimeter and in which the yolk had begun to form as opaque speckling; and (3) opaque ova that ranged from 0.33 millimeter to approximately 1 millimeter. No ova were found between 0.30 and 0.33 millimeter.

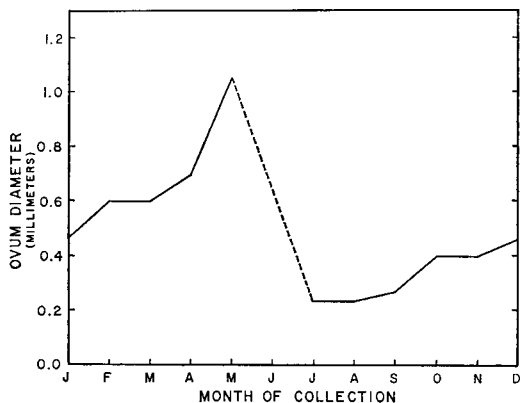


FIGURE 2.—Minimum size of largest type 2 or type 3 ova from monthly samples of mature female striped bass in Albemarle Sound. No samples were available in June (dashed line).

The diameter frequency from composite samples was plotted to show sizes of ova encountered in three months prior to spawning (Figure 1). It was found that each fish had only one of the following categories of ovaries: (1) those that contained only type 1 ova; (2) those that contained types 1 and 2; and (3) those that contained types 1, 2, and 3. Type 1 ova were found in all ages and sizes of striped bass. Type 2 ova were found during all months of sampling. Some type 2 ova developed into type 3 ova during the 3 months immediately after spawning. The remainder continued in type 2 throughout the year. A steady increase was found in the maximum size of the largest type 3 ova as the spawning season approached. Most fish were above 17 inches fork length, and were at least in age-group III before ovaries with type 3 ova were found.

The minimum size of the largest ova present in Albemarle Sound fish was determined by sampling each month throughout the year except during June when no samples were available (Figure 2). Ovum growth began slowly in the summer and fall, but increased rapidly as the spawning season approached. Apparent inflections in the curve are probably due to sampling error.

Type 3 ova collected from fish taken in the Roanoke River during the spring were between 0.80 and 1.50 millimeters in diameter at the time of spawning, and they averaged approximately 1 millimeter. Growth of the

TABLE 1.—Numbers of immature (I) and mature (M) female striped bass collected in Albemarle Sound by month during 1956-57 and 1957-58

| Age-group     | 1956-57 |   |          |    |          |   |         |    | 1957-58 |   |          |   |          |   |         |    |          |    |       |     |       |    |
|---------------|---------|---|----------|----|----------|---|---------|----|---------|---|----------|---|----------|---|---------|----|----------|----|-------|-----|-------|----|
|               | October |   | November |    | December |   | January |    | October |   | November |   | December |   | January |    | February |    | March |     | April |    |
|               | I       | M | I        | M  | I        | M | I       | M  | I       | M | I        | M | I        | M | I       | M  | I        | M  | I     | M   | I     | M  |
| II            | 13      | 0 | 16       | 0  | 13       | 0 | 7       | 0  | 23      | 0 | 22       | 0 | 25       | 0 | 58      | 0  | 17       | 0  | 38    | 0   | 11    | 0  |
| III           | 45      | 0 | 113      | 5  | 20       | 1 | 47      | 2  | 2       | 0 | 46       | 1 | 24       | 0 | 53      | 5  | 5        | 0  | 61    | 2   | 9     | 0  |
| IV            | 1       | 2 | 1        | 5  | 0        | 1 | 2       | 6  | 0       | 0 | 3        | 5 | 1        | 2 | 1       | 6  | 0        | 10 | 4     | 65  | 1     | 64 |
| V             | 0       | 1 | 0        | 3  | 0        | 3 | 0       | 0  | 0       | 0 | 0        | 1 | 0        | 0 | 0       | 0  | 0        | 2  | 0     | 27  | 0     | 12 |
| VI            | 0       | 0 | 0        | 0  | 0        | 1 | 0       | 1  | 0       | 0 | 0        | 1 | 0        | 0 | 0       | 1  | 0        | 2  | 0     | 8   | 0     | 2  |
| VII and older | 0       | 2 | 0        | 0  | 1        | 2 | 0       | 1  | 0       | 0 | 1        | 1 | 0        | 1 | 0       | 3  | 0        | 1  | 0     | 2   | 0     | 2  |
| Totals        | 59      | 5 | 130      | 13 | 34       | 8 | 56      | 10 | 25      | 0 | 72       | 9 | 50       | 3 | 112     | 15 | 22       | 15 | 103   | 104 | 21    | 80 |

ova from approximately 0.20 to 1 millimeter occurred between spawning seasons (Figure 2). Therefore the following maturity criteria were established: (1) if the largest type 2 or type 3 ovum found was equal to or greater than the minimum size of ova for a given month as shown in Figure 2, it was presumed that the fish would spawn the following spring, and the fish was considered mature; (2) fish with small translucent ova only were considered immature fish which would not spawn for at least a year following the coming spawning season. Thus fish with type 1 ova are immature, and those with types 2 and 3 are mature.

Other workers have also established criteria to indicate spawning potential in striped bass. Their findings support those of the present study. Scofield (1931) found that striped bass with ova exceeding 0.29 millimeter were spawners in California. His conclusions were based in part on a comparison of the percentage of fish in spawning and non-spawning condition before and after the spawning season. Jackson and Tiller (1952) stated that striped bass from Chesapeake Bay having ova averaging 0.75 millimeter or more in diameter in early spring could be expected to spawn that year. In our study, fish with ova averaging 0.70 millimeter and showing external evidence of becoming ripe were found in March and April in Albemarle Sound. These ova would have increased in size to full maturity during the spawning season of that year.

#### *Differences within type 1 ova*

The occurrence of two sizes of type 1 ova in striped bass depended upon whether or not the fish were sexually mature. The only

ova found in immature fish were those of type 1 which averaged 0.086 millimeter in diameter. Mature fish had type 1 ova which averaged 0.124 millimeter in diameter plus at least one of the other two types. The average difference between type 1 immature and type 1 mature ova was 0.038 millimeter. Scofield (1931) reported that small ova in striped bass collected in California averaged 0.125 millimeter. Merriman (1941) and Jackson and Tiller (1952) reported 0.07 millimeter as being the average size of small ova for striped bass collected in Connecticut and Maryland. None of these researchers reported two size groups of type 1 ova.

#### *Age of spawners*

Female striped bass were categorized by age groups as mature and immature fish (Table 1). The percentages of mature fish are presented by age group in Figure 3. Three and four percent of age-group III fish

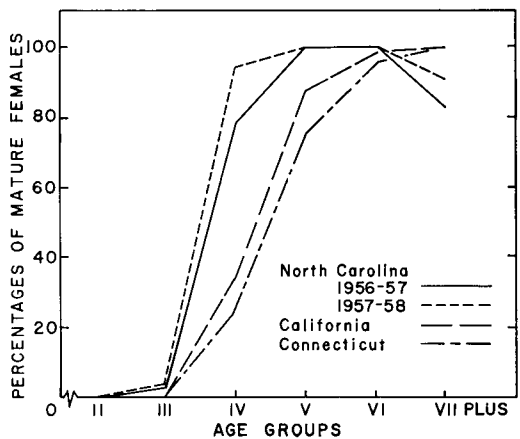


FIGURE 3.—Percentages of mature female striped bass by age from different regions.

were capable of spawning subsequent to the commercial fishing seasons of 1956-57 and 1957-58. Seventy-eight and 94 percent of age-group IV were mature, and all fish of age-groups V and VI were mature. In age-group VII and older, one of the six fish taken in the first year of sampling and one of the eleven fish taken in the second year contained no type 3 ova.

The percentages of spawners found by workers in different regions varied by age group. In our study of North Carolina fish, some of those in age-group III were found to be capable of spawning, but none capable of spawning at that age were found in other regions (Figure 3). Both spawners and non-spawners were found among age-groups IV, V, and VI in Connecticut (Merriman, 1941) and in California (Scofield, 1931). Spawning by all females was indicated first at age-group VII by these workers, and at age-group V in the present study.

A difference also occurred in the percentage of age-group IV spawners from the different regions. A higher percentage of fish from this age group were mature in North Carolina than in the other regions. A similar but smaller difference occurred for the age-group V fish. In age-group VI there were no major differences in the percentage of spawners from various regions. In Mary-

land, Jackson and Tiller (1952) found that most females spawned by the time they entered age-group IV or V, and that striped bass from this area were consistent spawners in age-groups VI through X, but these workers did not state the percentage of mature fish in individual age groups. Jackson and Tiller also suggested that a reduction in ova production may occur in some individuals after age-group X. The present study in North Carolina also indicates that some of the older fish do not spawn annually.

#### LITERATURE CITED

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